Researchers use magnets to cause programmed cancer cell deaths

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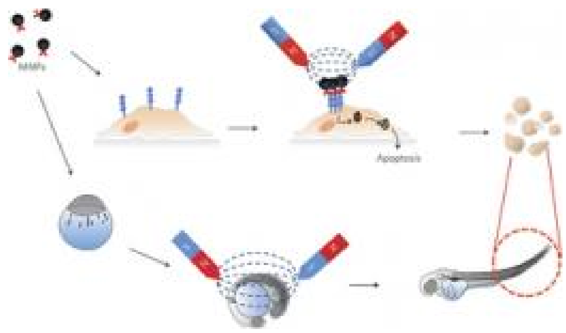

A schematic representation of the magnetic switch for apoptosis signalling in in vitro cells and in a zebrafish. Credit: (c) *Nature Materials* (2012) doi:10.1038/nmat3430

(Phys.org)—A team of researchers in South Korea has developed a method to cause cell death in both living fish and lab bowel cancer cells (*in vivo* and *in vitro*) using a magnetic field. The application of the magnetic field, as described in their paper published in the journal *Nature Materials*, triggers a "death signal" that leads to programmed cell death.

A major problem with treating cancer is how to effectively and efficiently apply a therapy, one that discriminates between cancer and healthy cells: killing the bad while retaining the good. Numerous methods have been tried over the years with varying degrees of success. In this new research, the team has been experimenting with the introduction of iron oxide nanoparticles, which attach to antibodies, into the system. The antibodies, in turn, bind to tumor cell receptors. When a magnetic field is introduced, the nanoparticles bunch up or cluster, which triggers a natural response called a death signal. When that happens, apoptosis (aka, programmed cell death) occurs, causing destruction of the tumor.

The work is based on apoptosis, a process that continually occurs in living organisms. This process is marked by biochemical events that lead to changes in cells causing their death; it is referred to as a programmed death because it controls the way cells grow in multi-cellular organisms. One clear example is the way cells between the fingers are allowed to die, while digits grow as individual members. Therefore, apoptosis is considered a healthy process as opposed to necrosis, where cells die due to trauma. Normally the process occurs when old or faulty cells are detected, such as when skin cells are damaged from exposure to the elements. When such cells are detected, chemicals are delivered which cause the cells to break apart, effectively killing them. In the present study, researchers took advantage of this process by causing such chemicals to be sent to tumor cells.

The researchers applied zinc-doped iron oxide nanoparticles to colon cancer cells, which naturally bind to antibodies. Those antibodies then bind very strongly to what is known as the death receptor 4(DR4) which exists on DLD-1 colon cancer cells. When a magnetic field is applied, the death receptor sends out a signal telling the system to attack the cell. Chemicals are then sent, killing the tumor.

In their experiment, the team found that more than half of the tumor cells exposed to the treatment were killed, while none of the untreated cells died. Unfortunately, other experiments with zebra fish resulted in the growth of abnormal tails. The team notes that their research is still in its infancy and that far more research will need to be done to see if the process can be refined and eventually tested in human trials.

More information: A magnetic switch for the control of cell death signalling in in vitro and in vivo systems, *Nature Materials* (2012) doi:10.1038/nmat3430

Abstract
The regulation of cellular activities in a controlled manner is one of the most challenging issues in fields ranging from cell biology to biomedicine. Nanoparticles have the potential of becoming useful tools for controlling cell signalling pathways in a space and time selective fashion. Here, we have developed magnetic nanoparticles that turn on apoptosis cell signalling by using a magnetic field in a remote and non-invasive manner. The magnetic switch consists of zinc-doped iron oxide magnetic nanoparticles5 (Zn0.4Fe2.6O4), conjugated with a targeting antibody for death receptor 4 (DR4) of DLD-1 colon cancer cells. The magnetic switch, in its On mode when a magnetic field is applied to aggregate magnetic nanoparticle-bound DR4s, promotes apoptosis signalling pathways. We have also demonstrated that the magnetic switch is operable at the micrometre scale and that it can be applied in an in vivo system where apoptotic morphological changes of zebrafish are successfully induced.